(12) UK Patent Application (19) GB (11) 2 378 915 (13) A

(43) Date of A Publication 26.02.2003

(21) Application No 0120316.5

(22) Date of Filing 21.08.2001

(71) Applicant(s)
Lotus Cars Limited
(Incorporated in the United Kingdom)
Hethel, NORWICH, NR14 8EZ,
United Kingdom

(72) Inventor(s)
Anthony George Shute

(74) Agent and/or Address for Service
Boult Wade Tennant
Verulam Gardens, 70 Gray's Inn Road,
LONDON, WC1X 8BT, United Kingdom

(51) INT CL[7]
B29C 70/68 70/84 // B29L 12:00

(52) UK CL (Edition V)
B5A AB11 AB17 A1R214D A1R214E A1R214F A1R214 A1R422 A1R442 A1R456 A20T14 A20T3

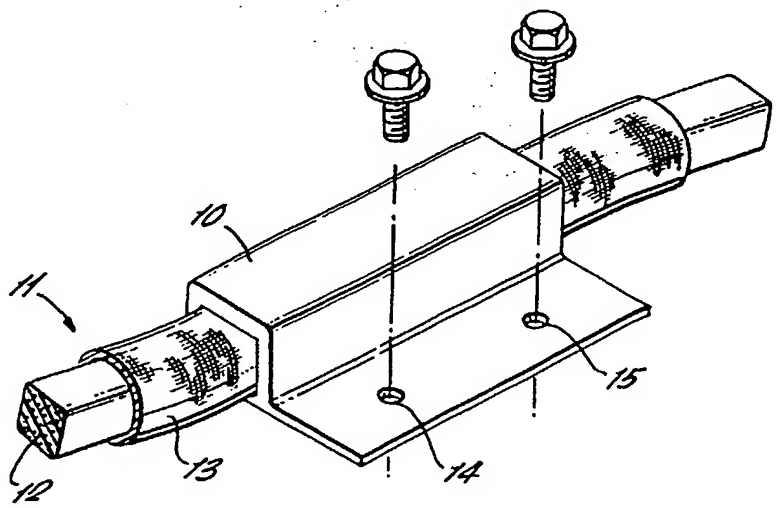
(56) Documents Cited
GB 2154520 A
DE 004423642 A1
FR 002783195 A
WO 2001/014128 A1
DE 003605012 A

(58) Field of Search
UK CL (Edition S) B5A AA2 AB10 AB11 AB13 AB17 AB2 AB23 ALA ALX AT14F AT14P AT3P, B7B BCJ BCL BCM
INT CL[7] B29C 33/00 33/12 33/76 35/00 35/02 39/00 39/0 39/10 39/22 39/26 39/38 45/00 45/03 45/14 45/26 45/36 45/72 45/73 70/00 70/02 70/68 70/84, B29L 12/00 23/00 31/30
Other: ONLINE: WPI, EPODOC, JAPIO

(54) Abstract Title
A method of forming a structural component

(57) A method of manufacture of a structural component, the method having the steps; forming flexible elongate components, each of which comprises a sheath of fibres surrounding a core of a flexible material, placing the flexible elongate components into a mould, introducing resin into the mould to flow around the fibres of the sheath, curing the resin, whereby there is formed a structural component/framework.

FIG. 1.



GB 2378915 A

FIG. 1.

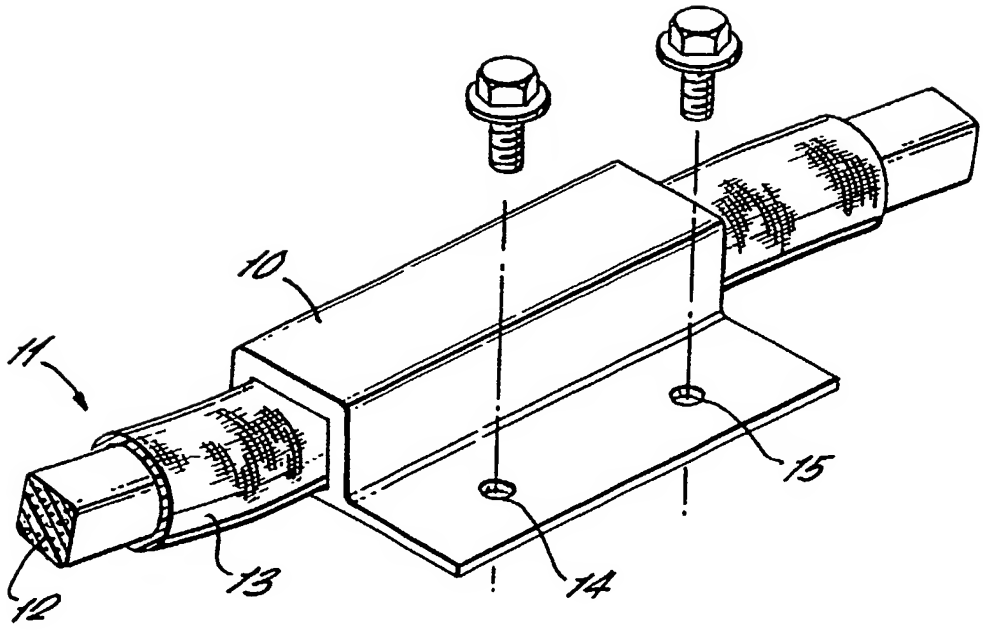


FIG. 2a.

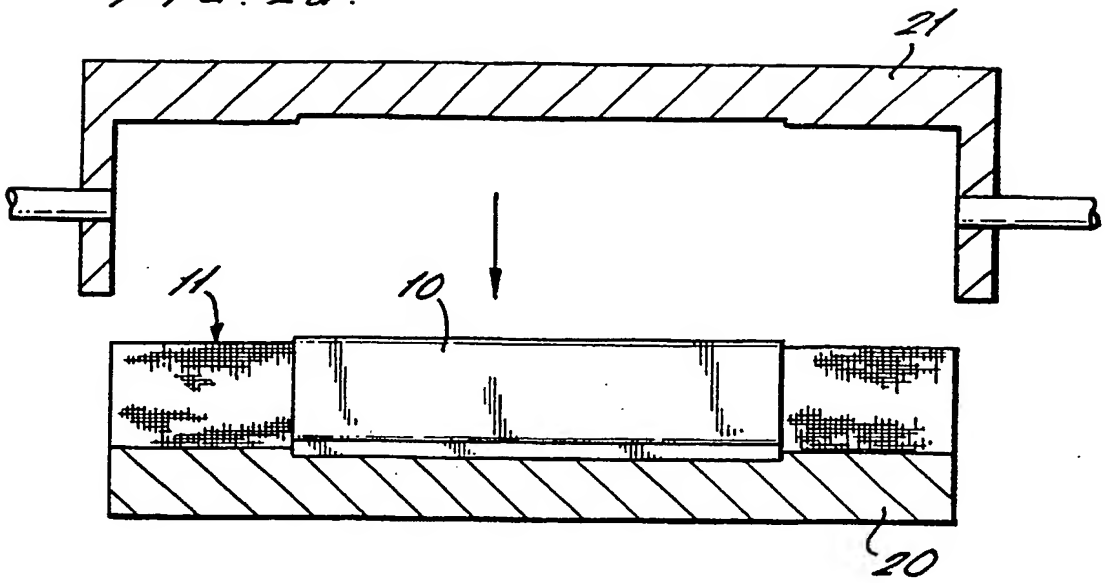


FIG. 2b.

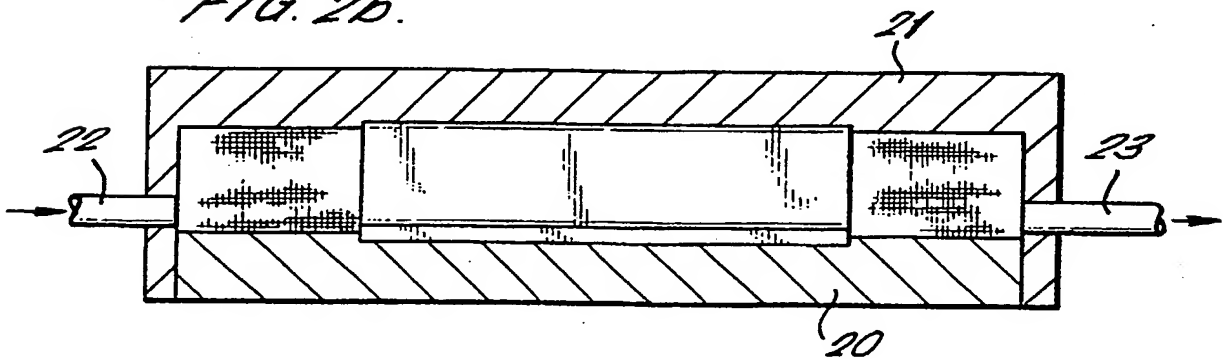


FIG. 2c.

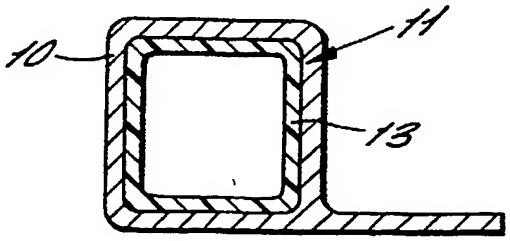


FIG. 3.

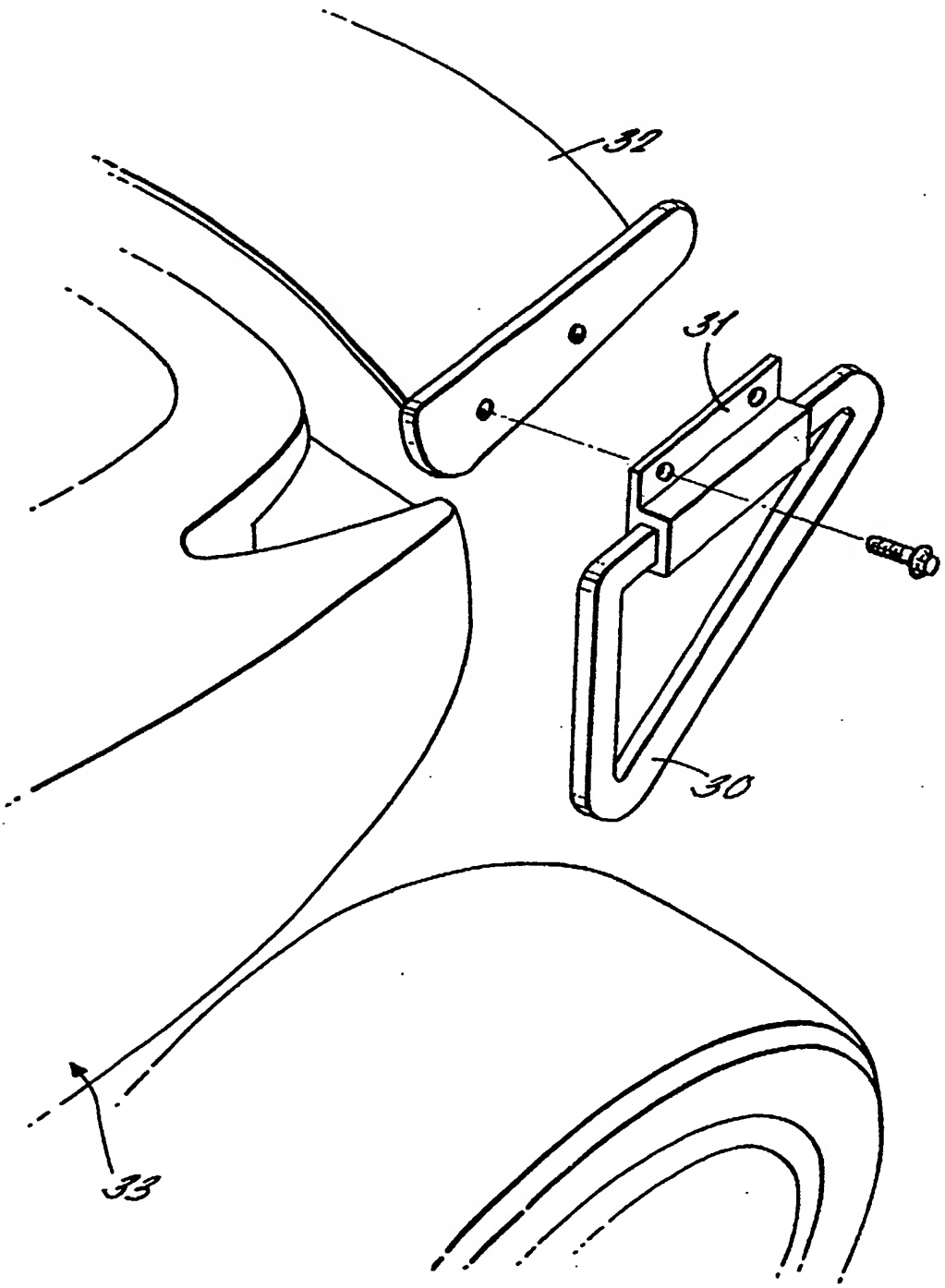


FIG. 4a.

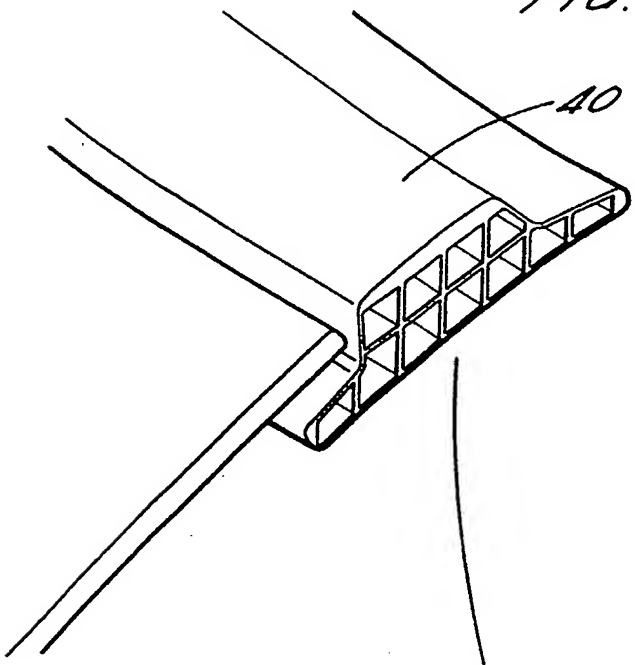


FIG. 4b.

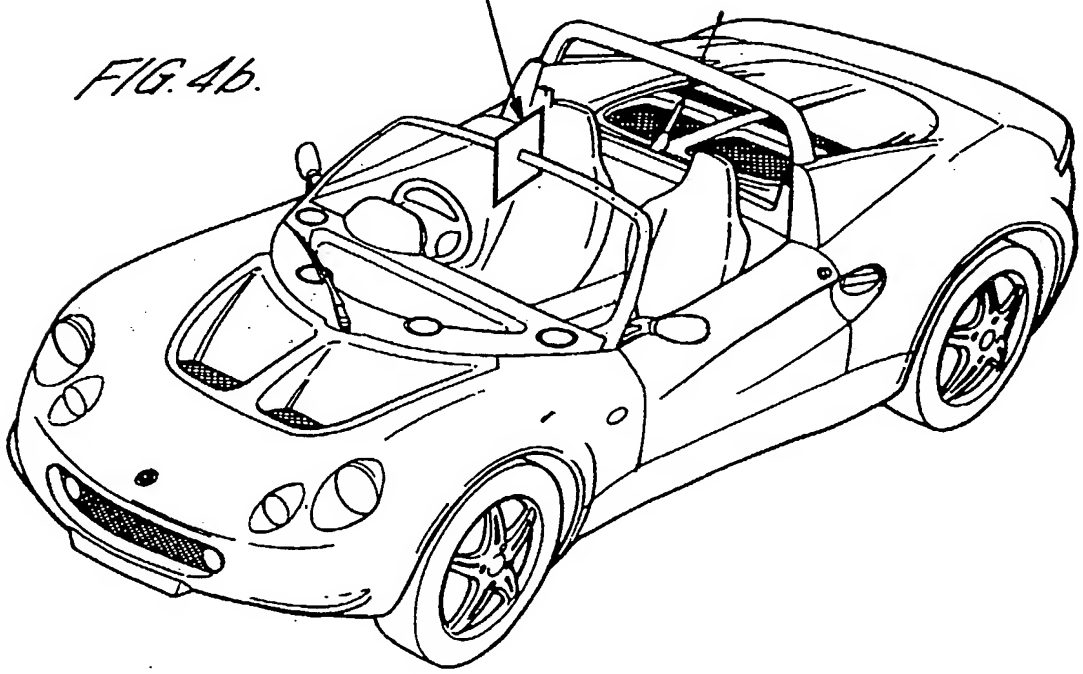


FIG. 5a.

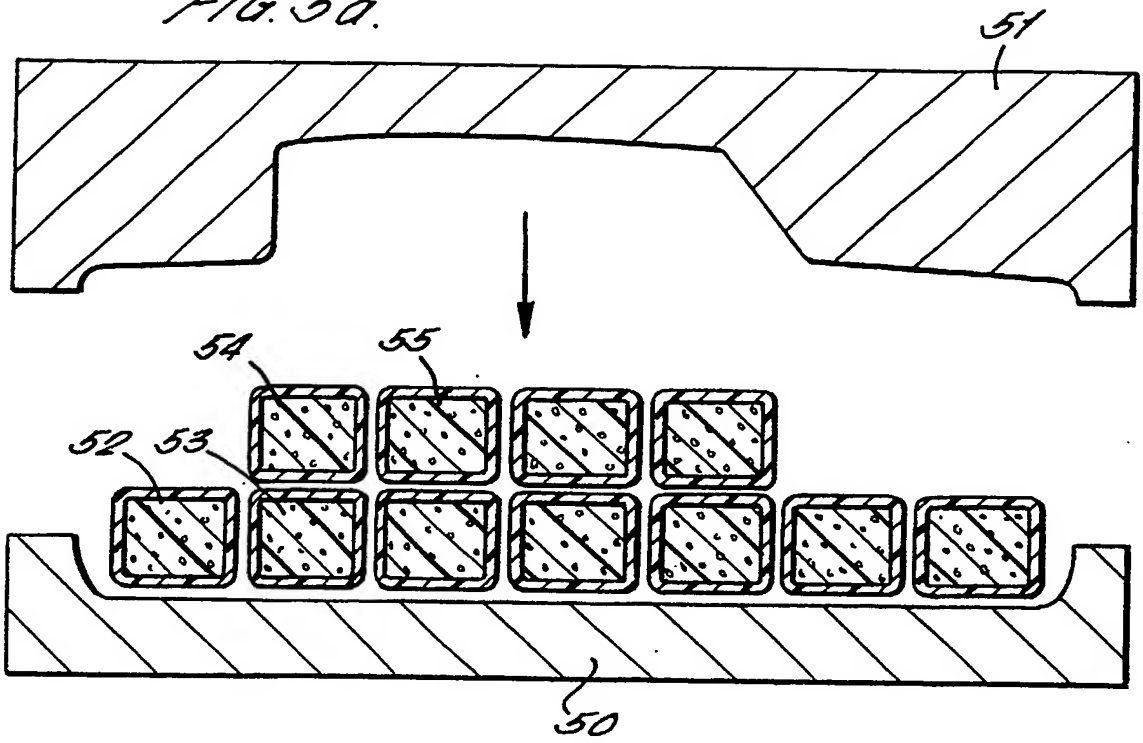


FIG. 5b.

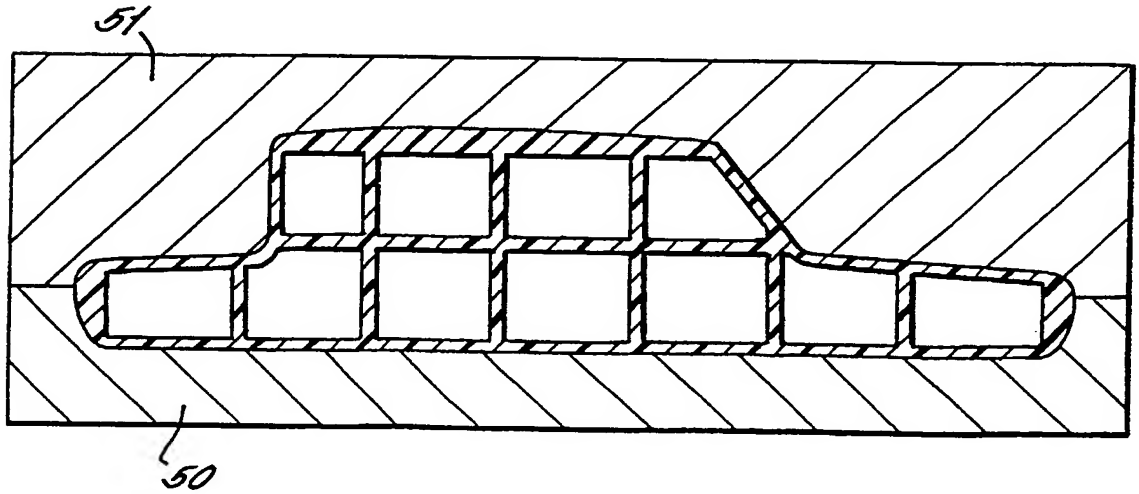
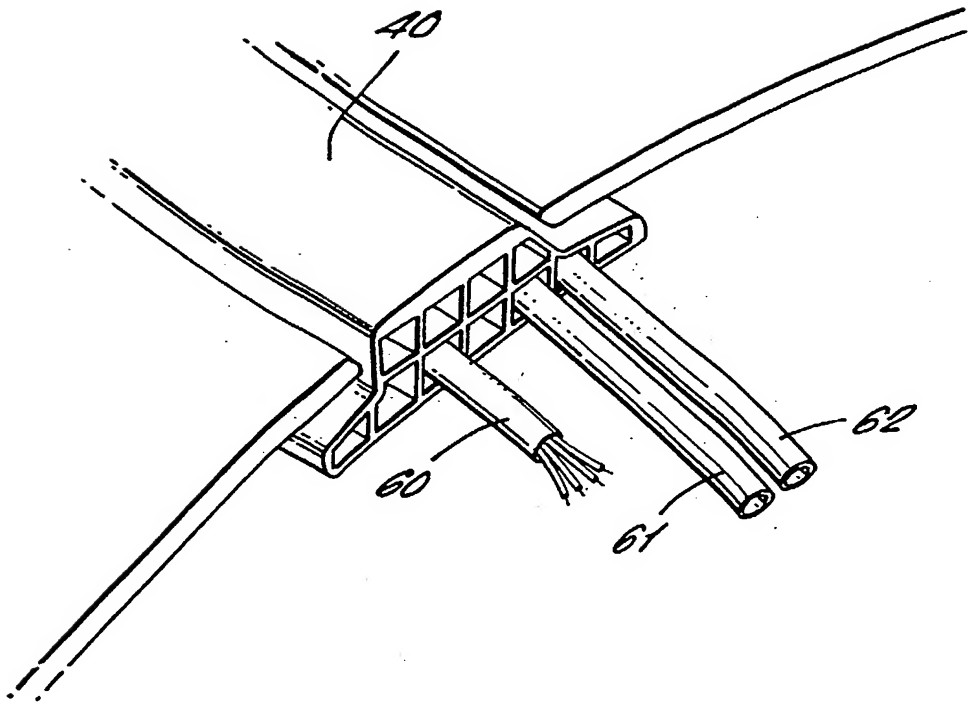


FIG. 6.



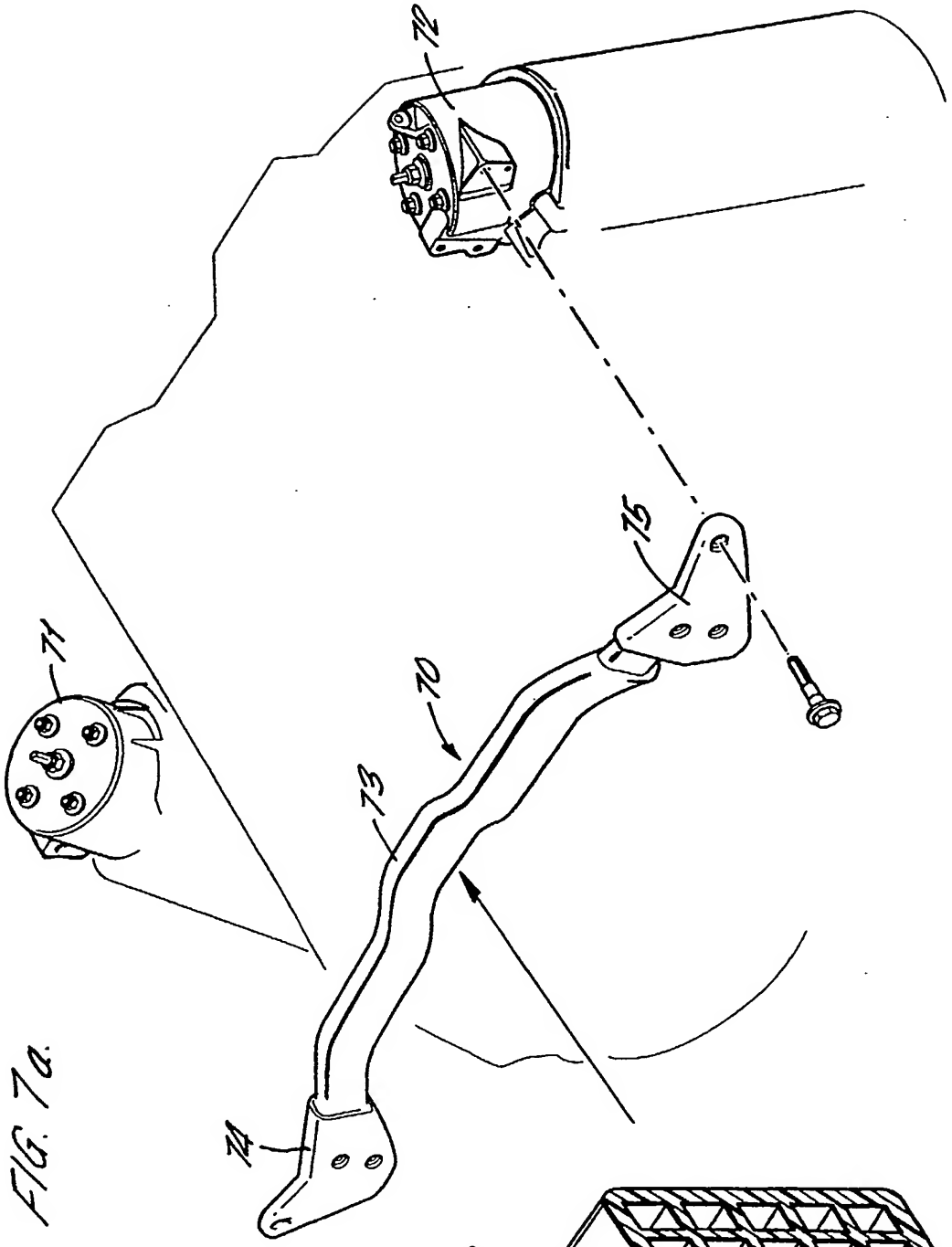


FIG. 7a.

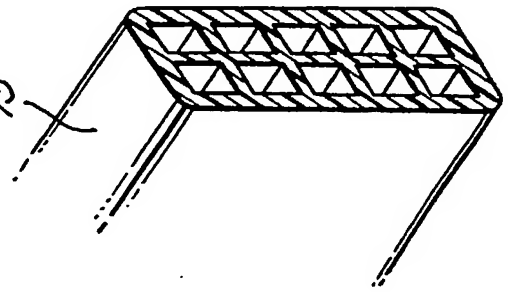


FIG. 7b.

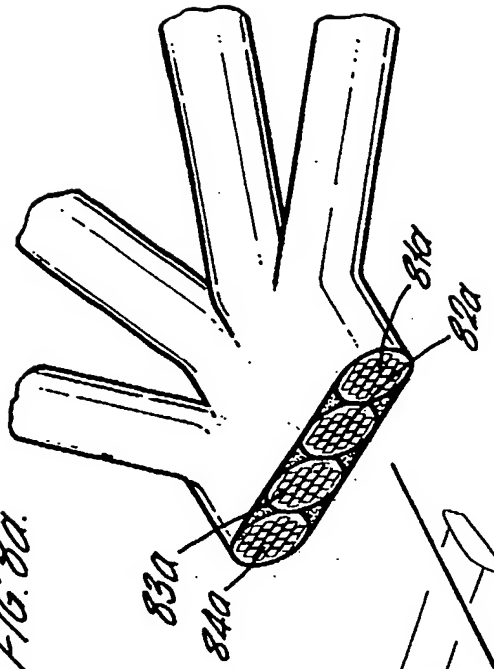


FIG. 8a.

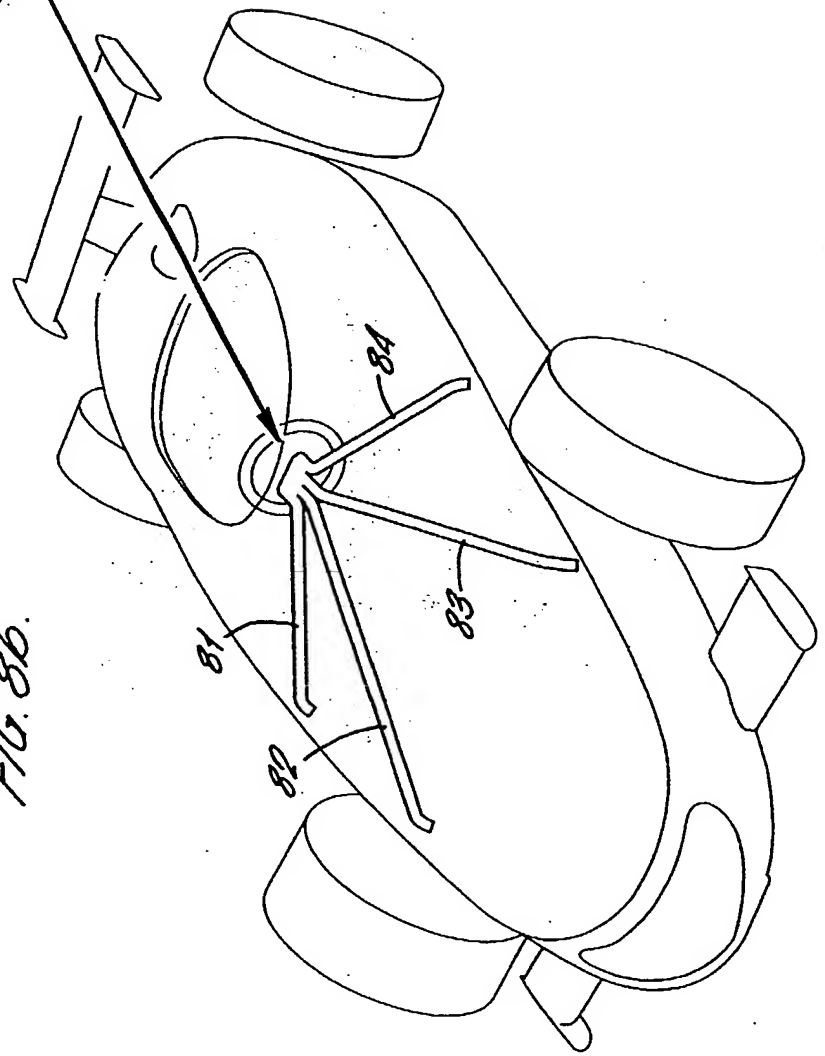


FIG. 8b.

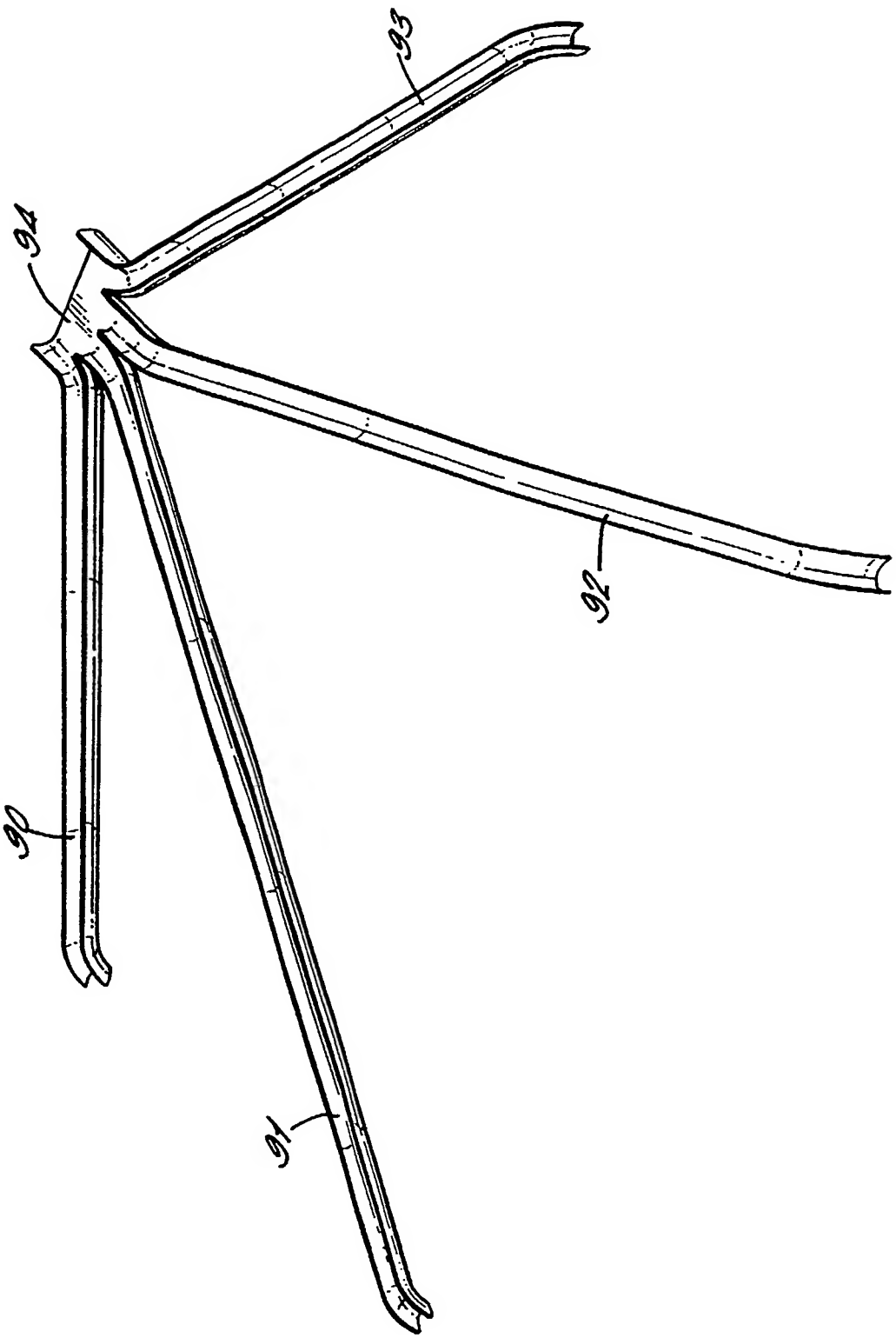


FIG. 9.

A METHOD OF FORMING A STRUCTURE AND A STRUCTURE FORMED BY THE METHOD

The present invention relates to a method of forming a structure for an automobile and a structure formed by the method.

In International patent application No. WO01/14128 there is described an elongate cored reinforcement of constant cross-section used to form a composite moulded article. The reinforcement comprises an envelope of strength giving fibres, such as carbon fibres, surrounding a core of expansible material such as closed cell foam material. Reinforcement is used in a method of forming a structure, the latter comprising laying in a mould at least one length of the reinforcement, closing the mould, reducing pressure in the mould in order to draw resin into the mould and then curing the resin in position around the reinforcement.

In order to use the structure formed by this method described in WO01/14128 it is necessary to attach brackets to some of the moulded methods. This can involve for instance drilling and tapping the moulded structure. This is difficult, time consuming and expensive and also weakens the structure.

In a first aspect the present invention provides a method of manufacture of a structural member comprising the steps of:

forming a flexible elongate component which comprises a sheath composed of fibres surrounding a core of a flexible material;

inserting a part of the flexible elongate

component into a void in a rigid component;

placing the flexible elongate component and the rigid component in a mould, with the said part of the flexible component located in the void in the rigid component;

introducing resin into the mould to flow around the fibres of the sheath; and

curing the resin, whereby:

there is formed a structural component comprising a rigid component fixed in position on an elongate component of composite material comprising fibres set in a resin.

In a second aspect the present invention provides a method of manufacture of a structural member comprising the steps of:

forming a plurality of flexible elongate components each of which comprises a sheath of fibres surrounding a core of a flexible material;

inserting a part of each of the plurality of flexible elongate components into the same void in a rigid component;

placing the plurality of flexible elongate components and the rigid component in a mould, with the said parts of the flexible elongate components located in the void in the rigid component and with the flexible elongate components lying together with each component abutting at least one other;

introducing resin into the mould to flow around the fibres of the sheaths of the plurality of elongate components; and

curing the resin, whereby:

there is formed a structural component comprising a rigid component fixed in position on an elongate multi-cellular component of composite material

comprising fibres set in a resin.

The specification WO01/14128 also describes the formation of multi cellular beams comprising a number of composite cored reinforcements moulded together to form a beam. The specification teaches that each structural element should comprise a plurality of reinforcements moulded together extending co-axially.

In a third aspect the present invention provides a method of manufacture of a structural framework comprising the steps of:

forming a plurality of flexible elongate components each of which comprises a sheath of fibres surrounding a core of a flexible material;

arranging the plurality of flexible elongate components in a mould with each flexible elongate component extending along a limb of the mould individual to the flexible elongate component and the flexible elongate components all having root portions which are laid together in a common root portion of the mould;

introducing resin into the mould to flow around the fibres of the sheaths of the plurality of elongate flexible members; and

curing the resin; whereby:

a structural framework is formed having a common root portion from which extends a plurality of limbs, the framework composed of a composite material of fibres set in resin.

In a fourth aspect the present invention provides a method of manufacture of a structural framework comprising the steps of:

forming a plurality of flexible elongate

components each of which comprises a sheath of fibres surrounding a core of a flexible material;

arranging the plurality of flexible elongate components in a mould in a plurality of bundles, the flexible elongate components of each bundle extending together along a limb of the mould individual to the bundle and the flexible elongate components of all the bundles having root portions which are laid together in a common root portion of the mould;

introducing resin into the mould to flow around the fibres of each sheath; and

curing the resin; whereby:

a structural framework is formed having a common root portion from which extends a plurality of limbs, the framework being composed of a composite material of fibres set in resin and each limb comprising a multi-cellular beam.

In a fifth aspect the present invention provides a method of manufacture of a structural framework comprising the steps of:

forming a plurality of flexible elongate components each of which comprises a sheath of fibres surrounding a core of a flexible material;

arranging the plurality of flexible elongate components in a mould with at least one flexible elongate component extending along a limb of the mould individual to the flexible elongate component and with a plurality of other flexible elongate components arranged together in a bundle and extending together along another limb of the mould individual to the bundle of flexible elongate components, the first flexible elongate component and at least some of the bundled flexible elongate components having root portions which are laid together in a common root portion of the mould;

introducing resin into the mould to flow around

the fibres of the sheaths of the plurality of elongate flexible members; and

curing the resin; whereby:

a structural framework is formed having a common root portion from which extends a plurality of limbs, the framework being comprised of a composite material comprising fibres set in resin and at least one limb comprising a multi-cellular beam.

An automobile requires runs of cables and piping. It is sometimes a difficult job to provide in a vehicle structure for voids through which cables and piping are run.

In a sixth aspect the present invention provides a method of constructing an automobile in which:

a structural member is manufactured by:

forming a flexible elongate component which comprises a sheath composed of fibres surrounding a core of flexible material;

placing the flexible elongate component in a mould;

introducing resin into the mould to flow around the fibres of the sheaths of the plurality of elongate flexible members; and

curing the resin at a temperature elevated sufficiently to cause the core of flexible material to at least partially disintegrate; whereby:

the manufactured structural member is an elongate member of composite material comprising fibres set in resin and has a void running longitudinally therealong formed by the disintegration of the core of flexible material;

and in the method:

pipework and/or cabling of the automobile is led

through the void running longitudinally along the structural member, the void serving as a conduit for the pipework and/or cabling.

In a seventh aspect the present invention provides a method of constructing an automobile in which:

a structural beam is manufactured by:

forming a plurality of flexible elongate members each comprising a sheath comprised of fibres surrounding a core of flexible material;

placing the plurality of flexible elongate components together side by side in a mould;

introducing resin into the mould to flow around the fibres of the sheaths of the plurality of elongate flexible members; and

curing the resin at a temperature elevated sufficiently to cause each core of flexible material to at least partially disintegrate; whereby:

the manufactured structural beam is a multi-cellular structural beam of composite material comprising fibres set in resin and has a plurality of voids running longitudinally therealong formed by the disintegration of the cores of flexible material;

and in the method:

pipework and/or cabling of the automobile is led through a plurality of the voids running longitudinally along the structural member, the voids serving as conduits for the pipework and/or cabling.

Preferred embodiments of the present invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a view of a bracket located surrounding a sleeved member prior to fixing of the

bracket in position on the sleeved member;

Figures 2a, 2b and 2c are schematic drawings showing the process by which the bracket is fixed in place on a composite material which comprises a sleeve as illustrated in Figure 1;

Figure 3 shows how a bracket fixed on a support by the method of the present invention can be used to support a spoiler of an automobile;

Figure 4a shows in cross section a front header rail of the vehicle and Figure 4b shows a front header rail in place in an automobile;

Figures 5a and 5b are schematic representations illustrating how the front header rail shown in Figures 4a and 4b is manufactured;

Figure 6 is an illustration of how cables and piping can be run through the front header rail of Figures 4a and 4b;

Figure 7a shows an arrangement of a structural beam with brackets for use in the vehicle, the structural beam with brackets being manufactured according to the method of the present invention;

Figure 7b shows a cross-section through the structural beam of Figure 7a;

Figure 8a shows a detail of a steering wheel support structure made according to the method of the present invention and Figure 8b is an illustration of the steering wheel support structure in use; and

Figure 9 is a schematic representation of a mould used to manufacture the steering wheel support structure illustrated in Figures 8a and 8b.

In Figure 1 there can be seen a bracket 10 of extruded aluminium (or aluminium alloy). There can also be seen a cored reinforcement 11 comprising an expansible core 12 of closed cell foamed material and a surrounding sheath 13 of braided carbon fibres. The

expansible core 12 has a generally square or rectangular cross-section whilst the surrounding sheath 13 is circular or oval in cross-section.

According to the method of the present invention, the bracket 10 will initially be extruded with the required cross-section and then two tapped apertures 14 and 15 will be drilled in the bracket 10. A length of the cored reinforcement 11 will then be inserted through the open ended passage running through the middle of the bracket 10.

The bracket 10 with the cored reinforcement 11 extending therethrough will next be placed on the lower mould tool 20 of a pair of matched mould tools 20 and 21 as shown in Figure 2a. Once located in position on the lower mould tool 20 the upper mould tool will then be brought down covering the bracket 10 and the reinforcement 11 running therethrough. This can be seen in Figure 2b. Then resin such as epoxy resin is drawn in through the delivery channel 22 shown in Figure 2b by drawing air out of the channel 23 and thereby creating a vacuum in the mould formed between the two mould tools 21 and 20.

The creation of the vacuum in the mould will cause the expansible foam core 12 to expand and to push the surrounding sheath 13 of carbon fibre into engagement with the inner surface of the mould formed by the mould tools 20 and 21. The vacuum will also then draw the resin through the sheath (the resin not passing through the core of foamed material because the core of foamed material will be impermeable to the resin whereas the surrounding sheath of carbon fibres will be permeable).

Once the resin has been drawn completely through the mould formed between the mould tools 20 and 21 then the method moves on to the next stage. In this stage, the resin is cured at a raised temperature. During the process of curing the heat causes the foam core 11 to partially or completely disintegrate.

Figure 2c shows a cross-section through the bracket 10 and the composite strut 11 formed therein by the method described above. In the Figure 2c the sheath 13 comprises carbon fibres in a resin. The foamed core 12 has completely disintegrated to leave a void passing through the middle of the cross-section. It will also be noted that the sheath 13 has taken up the shape of the interior surface of the bracket 10.

By the method described above the extruded bracket 10 is fixed securely in place on a carbon composite tube. There is no need for mechanical fixing (e.g.by screws) of the bracket 10 to the hollow structural member formed by the composite carbon material.

In Figure 3 there can be seen a triangular hollow carbon fibre composite structural member 30 having mounted thereon a bracket 31. The combination of the hollow carbon fibre composite structural member 30 with the bracket 31 mounted thereon is formed by a method as described above. It will be appreciated that the overall triangular nature of the composite carbon fibre structural member 30 can be created by laying down the combination of flexible foamed material and surrounding carbon fibre sheath in a triangular shaped mould. The combination of the carbon fibre composite structural member 30 and the extruded aluminium bracket 31 is both lightweight and

also very stiff and strong. In Figure 3 the formed component is shown in a use fixing an aerofoil 32 to the rear of a vehicle 33.

Figure 4a shows in cross-section a front header rail 40 of a vehicle, Figure 4b showing where the front header rail 40 is located in use.

Whilst above in relation to Figures 1 to 2c the composite member described has been a composite member formed as a single cell, it is envisaged that the present invention can form structural members which are multi-cellular carbon fibre composite beams. Such multi-cellular beams are have been described previously in WO01/14128.

Figures 5a and 5b show how the header rail 40 can be made. A plurality of elongate sections of carbon sheath with expansible foamed cores are laid down on the lower part 50 of a mould comprising two mould parts 50 and 51. A plurality of such elongate sections 52, 53, 54, 55 are shown in Figure 5a.

Once the required number of elongate sections have been laid in the lower mould tool 50 then the upper mould tool 51 is brought down to clamp with the lower mould tool 50. Then the mould formed by the two mould tools 50 and 51 is evacuated (as described above) and resin is drawn into the mould to flow along the gaps in the sheaths of carbon fibre. Once again, the closed cell foam cores will be impermeable so that the resin will flow only along the carbon fibre sheaths. The foamed cores expand when the mould is evacuated so that each carbon fibre sheath is forced outwardly to engage a neighbouring sheath or sheaths or the surface of the mould tools.

In Figure 5b it can be seen that the various different lengths of sheath and core have changed shape upon the application of the vacuum to the mould in order to fill fully the mould cavity.

It is possible that powdered fusible binder may be carried on or in the carbon fibres of the sheaths, so that when a new sheath is laid down next door to a previously laid sheath as shown in Figure 5a, an infra-red heater would be used to fuse binder on the surface of a previously laid sheath so that the newly laid sheath is tacked to the previously laid sheath.

As mentioned above, once the resin has filled the mould cavity then the resin will be cured. In the process, the foamed cores disintegrate either in part or completely to leave voids.

The applicant has realised that the voids in the formed multi-cellular beam can be very useful and in Figure 6 there can be seen an electrical cable 60 which is run through one void in the multi-cellular beam forming the header rail 40 and also flexible piping 61 and 62 (for the heating and cooling system or for the ventilation system or for breather tubing) again running through voids in the multi-cellular beam forming the header rail 40. Thus, within the ambit of the invention there is a method of manufacturing an automobile which comprises introducing and leading through voids extending longitudinally in a multi-cellular beam elements such as electrical cables and piping. Indeed, it is within the ambit of the present invention to choose the cross-section and size of closed-cell foam cores so that the resulting structural member has conduits of the required shape

and size for use in carrying cabling or piping.

Figure 7 shows a structural beam 70 which is used as a strut between two suspension towers 71 and 72 of a vehicle. It is advantageous that the beam 70 is lightweight whilst being very strong and very stiff. The beam 70 is formed of carbon fibres set in resin and has two metallic end brackets 74 and 75, The overall component is formed by the method of manufacture of the present invention in that initially a bundle of carbon fibre sheaths each with a foamed core interior will be laid in a mould, with the ends of the sheaths inserted into sockets provided in the metallic bracket members 74 and 75. Typically, the sockets will be of a size smaller in cross-section than the sum of the cross-sectional areas of the foam cores when the foam cores are in their natural relaxed state. This means that the plurality of foam cores must be compressed in order to allow the surrounding carbon sheaths to be inserted into the sockets in the brackets 74 and 75.

The brackets with the inserted carbon sheaths in foam cores and the plurality of lengths of sheath with inner foam core are laid together in a mould tool. In this embodiment of the method it is preferable that the mould tool size is such that the foam cores are all compressed when the two parts of the mould are brought together. Then it is preferable that the resin is injected under pressure into the closed mould (as opposed to being drawn in by a vacuum). The injection of resin is advantageous so that the resin can be forced along the carbon sheaths into the sockets in the metallic brackets 74 and 75. The compression of the foam cores during the bringing

together of the mould tool tool parts ensures that the foam cores themselves do not compress overly under the pressure of the resin introduced during the injection process.

Once the injection of resin has been completed then the injected resin is cured and the formed component removed from the mould tool. The mould tool will have an overall shape designed to impart to the finished article the required shape and configuration. The strut 73 will be a multi-cellular carbon fibre composite strut and a typical cross-section is shown in Figure 7b.

The applicant has also appreciated that a plurality of multi-cellular beams can be joined together in order to provide a framework structure. In Figure 8b there is shown a steering wheel support framework comprising four multi-cellular structural beams 81, 82, 83 and 84 which have proximal ends (nearest to the steering wheel) all joined together and distal ends which are spaced apart from each other in order to provide the strength and stiffness required for support of the steering wheel.

In Figure 8a it can be seen that the proximal ends 81a, 82a, 83a and 84a of the multi-cellular beams 81, 82, 83 and 84 are all joined together. This is achieved by placing the proximal ends together in a mould and injecting resin to surround the proximal ends of the multi-cellular beams which are laid side by side in the mould.

In Figure 9 there is shown schematically a mould tool suitable for the manufacture of the

steering wheel support shown in Figure 8b. A bundle of flexible elongate components comprising carbon sleeves covering foam cores will be laid in each of the four arms 90, 91, 92 and 93 and the ends of all of the elements will be placed together side by side in the section 94 of the mould. Resin will then be introduced into the mould and will flow along the carbon fibre sheaths and will in the part 25 of the mould surround the ends of all of the carbon fibre sheaths so as to form in the finished product a common root portion from which four different multi-cellular beams extend.

It is possible to vary the last described method by laying only one elongate flexible member in each limb of the mould or by laying one elongate flexile member in one limb and a bundle of flexible elongate members in another limb.

It is possible with any of the methods of manufacture above to incorporate additional fabric foam and metal inserts in the moulds as the structures are being manufactured so as to enable the structure to withstand large or localised loads during use.

CLAIMS

1. A method of manufacture of a structural member comprising the steps of:

forming a flexible elongate component which comprises a sheath composed of fibres surrounding a core of a flexible material;

inserting a part of the flexible elongate component into a void in a rigid component;

placing the flexible elongate component and the rigid component in a mould, with the said part of the flexible component located in the void in the rigid component;

introducing resin into the mould to flow around the fibres of the sheath; and

curing the resin, whereby:

there is formed a structural component comprising a rigid component fixed in position on an elongate component of composite material comprising fibres set in a resin.

2. A method of manufacture of a structural member comprising the steps of:

forming a plurality of flexible elongate components each of which comprises a sheath of fibres surrounding a core of a flexible material;

inserting a part of each of the plurality of flexible elongate components into a void in a rigid component;

placing the plurality of flexible elongate components and the rigid component in a mould, with the said parts of the flexible elongate components located in the void in the rigid component and with the flexible elongate components lying together with each component abutting at least one another;

introducing resin into the mould to flow around the fibres of the sheaths of the plurality of elongate

components; and

curing the resin, whereby:

there is formed a structural component comprising a rigid component fixed in position on an elongate multi-cellular component of composite material comprising fibres set in a resin.

3. A method as claimed in claim 1 or claim 2 wherein the rigid component is a metallic component and the method comprises additionally the step of:

forming the rigid component by extruding the component with the void being formed during extrusion.

4. A method as claimed in any one of claims 1 to 3 wherein each core is formed of an expansible material and the method comprises the steps of:

evacuating air from the mould when the flexible elongate component(s) and the rigid component are inside in order to draw resin into the mould; and

each core expanding in a vacuum created by evacuation of air from the mould and forcing the surrounding sheath(s) into abutment with each other and/or into abutment with the inwardly facing surfaces of the mould and the inwardly facing surfaces which define the void of the rigid component.

5. A method as claimed in any one of claims 1 to 3 wherein the core is formed of a compressible material and the method comprises the steps of:

compressing a part of each core whilst inserting the relevant part of each flexible elongate member into the void so that the compressed part of each core forces the relevant part of the sheath into abutment with a sheath of a neighbouring flexible elongate component and/or with the inwardly facing surface which defines the void in the rigid component;

compressing the remainder of each core when

placed in the mould with the flexible elongate component and the rigid component therein so that the remainder of each core forces the surrounding sheath into abutment with the sheath of a neighbouring flexible elongate component and/or with the inwardly facing surfaces of the mould.

6. A method as claimed in any one of the preceding claims wherein each core is of a flexible material impermeable to the resin.

7. A method as claimed in any one of the preceding claims wherein each core of flexible material disintegrates during the curing process to leave a void whereby the elongate component of the formed structural member is a hollow component.

8. A method of manufacture of a structural framework comprising the steps of:

forming a plurality of flexible elongate components each of which comprises a sheath of fibres surrounding a core of a flexible material;

arranging the plurality of flexible elongate components in a mould with each flexible elongate component extending along a limb of the mould individual to the flexible elongate component and the flexible elongate components all having root portions which are laid together in a common root portion of the mould;

introducing resin into the mould to flow around the fibres of the sheaths of the plurality of elongate flexible members; and

curing the resin; whereby:

a structural framework is formed having a common root portion from which extends a plurality of limbs, the framework composed of a composite material of fibres set in resin.

9. A method of manufacture of a structural framework comprising the steps of:

forming a plurality of flexible elongate components each of which comprises a sheath of fibres surrounding a core of a flexible material;

arranging the plurality of flexible elongate components in a mould in a plurality of bundles, the flexible elongate components of each bundle extending together along a limb of the mould individual to the bundle and the flexible elongate components of all the bundles having root portions which are laid together in a common root portion of the mould;

introducing resin into the mould to flow around the fibres of each sheath; and

curing the resin; whereby:

a structural framework is formed having a common root portion from which extends a plurality of limbs, the framework being composed of a composite material of fibres set in resin and each limb comprising a multi-cellular beam.

10. A method of manufacture of a structural framework comprising the steps of:

forming a plurality of flexible elongate components each of which comprises a sheath of fibres surrounding a core of a flexible material;

arranging the plurality of flexible elongate components in a mould with at least a first flexible elongate component extending along a limb of the mould individual to the flexible elongate component and with a plurality of other flexible elongate components arranged together in a bundle and extending together along another limb of the mould individual to the bundle of flexible elongate components, the first flexible elongate component and at least some of the bunbled flexible elongate components having root portions which are laid together in a common root

portion of the mould;

introducing resin into the mould to flow around the fibres of the sheaths of the plurality of elongate flexible members; and

curing the resin; whereby:

a structural framework is formed having a common root portion from which extends a plurality of limbs, the framework being comprised of a composite material comprising fibres set in resin and at least one limb comprising a multi-cellular beam.

11. A method of constructing an automobile in which:

a structural member is manufactured by:

forming a flexible elongate component which comprises a sheath composed of fibres surrounding a core of flexible material;

placing the flexible elongate component in a mould;

introducing resin into the mould to flow around the fibres of the sheaths of the plurality of elongate flexible members; and

curing the resin at a temperature elevated sufficiently to cause the core of flexible material to at least partially disintegrate; whereby:

the manufactured structural member is an elongate member of composite material comprising fibres set in resin and has a void running longitudinally therealong formed by the disintegration of the core of flexible material;

and in the method:

pipework and/or cabling of the automobile is led through the void running longitudinally along the structural member, the void serving as a conduit for the pipework and/or cabling.

12. A method of constructing an automobile in which:

a structural beam is manufactured by:

forming a plurality of flexible elongate members each comprising a sheath comprised of fibres surrounding a core of flexible material;

placing the plurality of flexible elongate components together side by side in a mould;

introducing resin into the mould to flow around the fibres of the sheaths of the plurality of elongate flexible members; and

curing the resin at a temperature elevated sufficiently to cause each core of flexible material to at least partially disintegrate; whereby:

the manufactured structural beam is a multi-cellular structural beam of composite material comprising fibres set in resin and has a plurality of voids running longitudinally therealong formed by the disintegration of the cores of flexible material;

and in the method:

pipework and/or cabling of the automobile is led through a plurality of the voids running longitudinally along the structural member, the voids serving as conduits for the pipework and/or cabling.

13. Use of a structural member as claimed in any one of claims 1 to 7 as a structural member of an automobile.

14. Use of structural framework as claimed in any one of claims 8 to 10 as structural framework of an automobile.

15. A method of manufacture of a structural member substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

Application No: GB 0120316.5
Claims searched: 1
Examiner: Damien J Huxley
Date of search: 31 December 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): B5A: AA2, AB2, AB10, AB11, AB13, AB17, AB23, AT3P, ALA, ALX, AT14F, AT14P
B7B: BCJ, BCL, BCM

Int Cl (Ed.7): B29C: 33/00, 33/12, 33/76, 35/00, 35/02, 39/00, 39/02, 39/10, 39/22, 39/26, 39/38, 45/00, 45/03, 45/14, 45/26, 45/36, 45/73, 45/72, 70/00, 70/02, 70/68, 70/84
B29L: 12/00, 23/00, 31/30

Other: ONLINE: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2154520 A	(FORD) see the figures especially, although the whole document is relevant.	1
X	WO 01/14128 A1	(CRANFIELD UNIVERSITY) see line 31 of page 3 to line 9 of page 4 and the figures.	1
X	FR 2783195 A1	(ROCHER) see the figures and WPI Abstract Accession Number 2000-259305.	1
A	DE 4423642 C1	(DAIMLER BENZ) see the figures and WPI Abstract Accession Number 1995-345668.	
X	DE 3605012 A	(MALMSTROEM) see the figures and WPI Abstract Accession Number 1986-226573.	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.